M E M O R A N D U M

DEPARTMENT OF ENVIRONMENTAL QUALITY

Technical Services Division

Subject: Guidance Memo No. 97 - 2005
Development of Total Maximum Daily Loads (TMDL)

To: Regional Directors

From: John Daniel, Director

Date: October 16, 1997

Copies: Regional Permit Managers, Regional Compliance and Enforcement Managers, Larry G. Lawson

Federal law and regulations require the states to calculate and submit to EPA a Total Maximum Daily Load (TMDL) for all water quality limited stream segments. The states and EPA have been slow in implementing this requirement. However, recent court decisions against states and EPA have resulted in a high priority being set for submittal of TMDL's to EPA. DEQ is desirous of avoiding similar wasteful litigation in Virginia and should begin ASAP to submit TMDL's to EPA for their review and approval.

TMDLs for the dry weather/low flow condition can be calculated, public noticed and submitted to EPA as part of the permit issuance process. This approach will result in the development of TMDLs for all point source dominated segments as permits are issued. Since TMDL development will be concurrent with permit issuance, it should be possible for DEQ to develop most of the required point source TMDLs within a six to seven year period.

Please note that DEQ will only develop TMDLs associated with point sources of pollutants for the dry weather/low flow condition. The Department of Conservation and Recreation (DCR) has responsibility for nonpoint source programs in Virginia and that agency will be developing the nonpoint source TMDL's. Where both point and nonpoint sources contribute to the problem DEQ and DCR will work together to develop a TMDL for the segment. This guidance does not address the non point source aspect of TMDL development as the procedures have not been finalized to date.

The attached memorandum contains our recommendations for the development, content, format and submittal of dry weather, low flow, point source TMDLs to EPA.

DISCLAIMER

This document provides technical and procedural guidance to the permit staff on the development of a TMDL. This document is guidance only. It does not establish or affect legal rights or obligations. It does not establish a binding norm and is not finally determinative of the issues addressed. Agency decisions in any particular case will be made applying the State Water Control Law, the Federal Clean Water Act and the implementation regulations on the basis of the site specific facts when permits are issued.

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
Office of Permit Support
629 East Main Street Richmond, Virginia 23219

M E M O R A N D U M

Subject: Recommended Guidance for the development of TMDLs

To: John Daniel

From: M. Dale Phillips

Date: October 16, 1997

Copies: Hassan Vakili, Robert Beasley, Ron Gregory, Charles Martin

Introduction:

The procedures, methods and tools required for the development of dry weather, point source TMDLs are much the same as are required for the establishment of permit limits. It results that, with minor changes in protocols, the format of permit packages and by providing some additional documentation, TMDLs can be developed by the regions concurrent with permit issuance. This should allow us to develop dry weather, point source TMDLs without any wholesale changes to our permitting/planning procedures. Once the procedures become routine it may, in fact, result in more efficient and consistent documentation of the permit requirements.

DCR is responsible for wet weather (nonpoint) TMDLs so there is no need to perform calculations in addition to those normally done for a permit issuance.

The main requirements will be to gather all the materials relative to the establishment of permit limits into one section (TMDL) of the fact sheet, provide some additional documentation required by the TMDL regulations and minor modifications in the way we submit materials to EPA.

Definitions:

The definitions that will be used in this guidance are:

Waste load allocation (WLA): the amount of a pollutant allocated to point source discharges. Note: in some cases this is essentially equal to the permit limit.

Load allocation (LA): the amount of pollutant allocated to nonpoint sources. Note: for dry weather TMDLs this may include only general background levels.

Margin of safety (MOS): a quantity set aside and not allocated to either point or nonpoint sources to account for estimation errors during derivation of the WLAs and LA. Note: the MOS is not a set aside for future growth and cannot be used as such!

Total Maximum Daily Load (TMDL): The amount of a pollutant, from all sources, that can be present in a stream without causing a violation of a water quality standard. It is the total allowable amount of a pollutant from all sources including:

Point source wasteload allocations,
Non-Point source allocations (includes background),
Margin of safety (to account for uncertainty in the analysis).

Note: EPA prefers the TMDL and its components be expressed in terms of a simple mass loading. This is not possible for many of our standards and that is why the definitions above use "amount" rather than loading. The word "amount" in the above definitions may refer to any valid expression of the **quantity** of a pollutant. Depending on the standard being evaluated and the technical requirements of the specific parameter, "amount" may refer to a mass loading, a concentration, a physical count, etc. The only restriction is that it must be quantitative and not qualitative in nature.

Water quality Limited Segment: A receiving water where the technology based minimum effluent limitations are not sufficiently stringent to allow attainment of all applicable water quality standards, including antidegradation and other narrative standards.

303(d) listed waters: Waters wherein one or more standards are not being attained and no approved TMDL exists for them. Note: these are, by definition, water quality limited.

Stream Segments Needing TMDLs:

TMDLs are required for all water quality limited stream segments and for all parameters having a water quality limit (including limits based on narrative standards). Note: TMDLs are not required for parameters that do not contribute to a water quality problem.

This represents a huge workload in terms of both stream segments and parameters that potentially need TMDLs. Available resources dictate that we cannot manage to develop all the required TMDLs in a short time frame. It is going to require years to accomplish this task.

As a first priority, it is recommended that a TMDL be developed concurrently with the permit when a permit is issued, reissued or modified that authorizes a discharge to a segment on the 303(d) list. In this manner, most of the high priority point source TMDLs can be developed during a six to seven year period.

As resources allow, it is also recommended that a TMDL be developed concurrently with any permit being issued that authorizes a discharge to a water quality limited segment.

Segments for which TMDL's will not be developed:

TMDL's will not be developed for segments that are on the list or are water quality limited due to inappropriate or erroneous standards and/or classification. Specifically, this includes the many swamps and wetlands in Virginia that are currently misclassified as class III or class IV waters but should be classified as class VII waters. These waters have a dissolved oxygen standard that is inappropriate and that cannot be attained. In these cases, the regional office should prepare a memorandum to OERS that identifies the water body, and the correct classification so that the error can be corrected and appropriate standards applied.

Note: Almost all waters that the swamp water guidance has been applied to will fall into this category.

Public Participation:

Federal regulations require that the public must participate in the development of a TMDL. The necessary public participation can be obtained by including the TMDL information in the public notice for permits authorizing discharges to segments for which a TMDL is being proposed.

Historically, TMDLs have been interpreted as some kind of a constant cap on the amount of pollutants that may be discharged to a stream under any and all conditions. This concept is in error. The TMDL requires reevaluation when any significant change occurs either to the stream or to the facility for any of the parameters that are addressed during development of the TMDL.

In order to maintain flexibility, to properly support the VPDES permit program and to provide for implementation, DEQ must have the ability to rapidly modify, update and/or correct TMDLs as new information becomes available. Since TMDLs will be developed concurrently with permit issuance, time associated with TMDL development needs to be roughly the same as the time required for a permit issuance, about 120 days. This means that care has to be taken to obtain and act on meaningful public input while avoiding any possible interpretation of the TMDL as a regulation.

Submittal of TMDLs to EPA for Approval:

We should use the existing procedures as much as possible for submittal of TMDLs to EPA. All TMDLs should be developed during permit preparation and documented in the fact sheet. The submittal of the draft permit package (majors) to EPA for review and approval will also constitute DEQ's submittal of the associated draft TMDLs for

major permits. The fact sheet or parts extracted from it will have to be submitted separately as the TMDL associated with minor permits. Note all TMDLs (related to both major and minor facilities) must be submitted to EPA for approval.

EPA regulations require that documentation of public participation (copy of the public notice) and the resolution of any comments received must be submitted as part of the final TMDL. These materials will not be available until after the permit is signed. This will present a minor difficulty in that EPA reviews major permits prior to the public notice and all of the required elements of the TMDL will not be available at that time.

The permit and TMDL will be considered to be draft until after public notice and the permit is signed. Once the permit is signed, a copy of the public notice, public notice verification and a memorandum detailing the resolution of any comments received should be attached to the final signed permit package sent to EPA.

> Note: this additional material is made necessary because we have to provide documentation of public participation and the response to comments received as part of the TMDL. This is not normally part of the permit package that EPA reviews, even for major permits. This will require that close liaison be maintained with EPA so that all their meaningful comments are received during their review of the draft TMDL. We must avoid the situation where a permit is issued based on a TMDL that EPA will not approve. We will work with EPA to achieve this end.

Where multiple discharges impact the same water quality limited segment, the TMDL for the entire segment should be developed during the first permit action in the section. The TMDL will have to be reviewed and revised/updated, if necessary, with each permit issued for a discharge to that segment. In these cases, care has to be taken to address all the required WLAs and LA for the segment each time a permit is issued. Note: this may require a longer lead time for permit development as the other permittees will have to be brought into the TMDL development and allowed an opportunity to comment.

If resources allow, TMDLs may be developed independently of permit issuance for both single and multiple discharge situations.

Development of TMDLs:

WLAs:

There are different approaches for identifying TMDLs and their components depending on the nature of the standard and the specific material being evaluated.

1. Materials for which a standard exists that specifies the

maximum amount of a pollutant that is allowable in the stream during specified flow conditions (may also be a minimum or a range).

This category includes such standards as: pH, temperature, fecal coliform, dissolved oxygen, nutrients in some cases, etc.

The actual TMDL for these materials is straight forward. The standard directly specifies the maximum amount of material that is permissible in the stream at a particular flow and therefore the TMDL, at the critical flow, must be numerically equal to the standard when both are expressed in the same units. However, the WLA, LA and MOS are not identified by the standard must be identified and documented in the TMDL. It is the identification and documentation of these components that is of importance for these materials. The evaluation for most materials in this category is normally made for the near field, e.g., very close to the discharge point (typically at the edge of the mixing zone) since that is the area of highest concentration. Simple, steady state mixing equations are generally used to determine the WLA for these materials. Application of these equations requires the specification of specific flows and concentrations. Generally some critical condition is specified by the standard and it is assumed that water quality will be better during all other conditions, so only the critical condition requires evaluation.

The models used to assess materials in this category are not suitable to evaluate the impact of variable or transient conditions, e.g., they cannot be used to evaluate the LA due to storms, etc. Therefore, when such models are applied, consideration of the LA component is limited to a simple steady state background value that applies at the critical low flow when the nonpoint sources of the pollutant associated with storm water runoff are relatively insignificant.

The routine procedures currently used to establish permit limits are adequate to evaluate the TMDL so no additional work is necessary other than slight modifications to the documentation and formatting of the permit package.

NOTE: The stream flow used to calculate the WLA may be limited by mixing zone requirements. This does not restrict the applicability of the equations.

2. **Materials for which a narrative standard exists.**

This category includes any material that is of concern relative to one of the general narrative standards.

Examples are: color, turbidity, solids, whole effluent toxicity, nutrients in some cases, etc.

The WLA and of necessity the TMDL for these materials must be based on professional judgement. The judgements may represent a consensus of agency opinion and be contained in agency guidance or may represent the opinions of one permit writer as applied on a case-by-case basis. No general criteria for estimating these TMDLs can be given. However, when such judgements are made, the judgement should begin with the TMDL, e.g., what can the stream tolerate? It is then necessary to divide this total among the various sources (e.g., WLA, LA and MOS). These must be specifically identified as part of the overall judgement and must be quantitative, e.g., expressed as measurable numbers.

3. Materials for which no standard exists but which have a direct impact on a material for which a standard does exits.

This category includes materials that are commonly limited in VPDES but for which no standard exists. Examples include: cBOD, nBOD and nutrients (when the nutrients result in an unacceptable diurnal variation in D.O.).

The WLA for this type material is generally obtained by the application of a predictive model that identifies the amount of material that a stream can assimilate without causing a violation of the associated standard. Nutrients that cause excessive algal growth which results in an excessive diurnal variation in dissolved oxygen are in this category. However, the most common material in this category is BOD relative to its impact on the dissolved oxygen standard.

The WLA for BOD (as well as nutrients) is generally derived by application of steady state mathematical models. Since steady state models yield only constant results, they can only be related to a long term relatively steady condition. These models are generally applied to evaluate conditions at the critical low flow. The LA due to storms, transient processes, etc. cannot be evaluated. Therefore, when such models are applied, consideration of the LA component is limited to a simple steady state background concentration that applies at the critical low flow (drought) condition when the nonpoint sources of the pollutant are relatively insignificant.

Note: even where dynamic models are used to predict eutrophication the consideration of point source inputs is almost always analyzed as a constant or steady state source and the above observations apply.

4. Materials for which the standard does not specify a maximum

allowable concentration but rather specifies the duration and frequency for allowable exceedences of a concentration criterion:

In this category are all the standards for toxic materials whose standards are written in terms of a numerical criterion, a duration and a recurrence interval, e.g.,:

Acute - 1 hour average concentration that cannot be exceeded more than once in 3 years on the average.

Chronic - 4 day average concentration that cannot be exceeded more than once in 3 years on the average.

There are several aspects of these standards that are fundamentally different from the historical standards for conventional pollutants. These differences must be kept in mind relative to a WLA and/or TMDL (and particularly public information) if findings that are extremely misleading are to be avoided:

- These standards do not specify a maximum concentration; thus, **any concentration whatsoever** above the criteria is acceptable providing it does not last too long and does not occur more frequently than once in three years.

- There is no particular flow associated with these standards; thus, the allowable exceedences of the criteria may occur at any flow, even very high flows. It is, of course, more likely that exceedences will occur during low flow conditions but, unlike conventional standards, the toxic standards do not prohibit exceedences during high flow periods.

  Note: Although we use complete mixing at a specified low flow as part of our routine procedure to calculate permit limits for these materials, neither the standards nor our procedures limit the expected exceedences to low flow periods.

- Due to staff limitations, we routinely use a combination of statistical analysis and simple mixing equations to estimate the WLA for these standards. However, the preferred approach is to utilize statistical or stochastic models to estimate the WLA. These procedures yield estimates of the duration and frequency of exceedences of the criteria but do not generally yield information relative to the maximum

concentration that may occur.

It results that the WLA calculations cannot be interpreted in a manner consistent with the simplistic concepts historically associated with TMDLs. In particular, the statistical models do not identify either a particular flow or a maximum concentration. They simply evaluate the recurrence frequency of a particular variable and compare it with the standard.

Note: Federal law requires that permit limits be written in terms of a daily maximum and a monthly average for industrial permits and a weekly average and a monthly average for POTWs. This requirement is not technically valid for materials whose standards are expressed statistically and whose permit limits are statistically derived. Such requirements should not have been applied to these limits, however, the interpretation of federal regulation by EPA, region III allows no alternatives. These limits are, in reality, based on a statistical analysis of the effluent and are expected to be exceeded once in each three year period but due to the regulations this cannot be recognized in the permit.

However, the TMDL applies in the stream and the inappropriate legal requirements for effluents do not apply. Thus, the TMDL can be properly expressed in units that are meaningful relative to the standard.

As a result of the above considerations, the permit limits for toxic materials and the TMDL for these materials will not be specified in the same units.

> The permit limit is expressed either as a maximum concentration or an average concentration and specifies the conditions allowable **in the effluent.**
>
> The TMDL will be expressed in terms of a one hour or 4-day average concentration that may not be exceeded more than once in three years and specifies the conditions allowable **in the stream.**

Although numbers will be provided to comply with the regulations as much as possible, the TMDL for these materials in reality consists of the analysis and documentation that demonstrate that the standard will be attained.

Again, the routine tools used to establish permit limits will be adequate for TMDL development.

Margin of Safety:

The margin of safety may be specified explicitly or implicitly. We generally do not specify it directly but implicitly include it in the assumptions according to which the TMDL and/or its components are derived. For example, during evaluation of a WLA it is generally assumed that:

- the STP flow is at its maximum design value.
- the stream flow is at some minimum flow.
- the temperature is at a particular critical value
- the pH is at a particular critical value.
- other important parameters are at critical values
- **these critical conditions all occur simultaneously and remain at the critical values indefinitely.**

The last assumption above is very conservative and provides an ample margin of safety that will apply to almost all of our point source TMDL calculations.

In those instances where the above assumption is not a part of TMDL development (e.g., BPJ limits, or statistical models for toxics), then the MOS will have to be addressed explicitly and a portion of the TMDL identified and set aside as the MOS. No explicit guidance can be given for this judgement-based MOS.

Load Allocation:

The Load allocation for nonpoint sources under wet conditions is extremely difficult to handle as its calculation depends on the definition of critical conditions. There is currently no national or state guidance or regulation that defines the critical conditions and as a result numerical TMDLs for wet weather conditions cannot presently be calculated.

However, during the dry weather, low flow condition, nonpoint sources are generally insignificant. Under these conditions the only part of the LA that is important is the general low flow background concentration and it is usually incorporated directly into the calculation of the WLA.

The only modification to our current procedures is that the LA and/or background will have to be specifically identified.

Dry Weather TMDLs:

The TMDL is the total amount of a pollutant that is allowable in a particular stream. As indicated above, it can be determined for dry conditions according to the following general protocol:

- The dry weather LA consists only of the background

concentration.

- The WLA is determined in one of several ways:
    - by an appropriate mixing model to estimate the dilution provided by the stream in cases where the standards directly specify the maximum amount of a pollutant that is allowable.
    - by application of a water quality model for materials that decay, where the area of interest is remote from the discharge point, or where the material that is being limited has no standard but impacts a material for which a standard does exist.
    - By application of statistical models or a combination of steady state and statistical models for the toxic standards.

      Note: where multiple dischargers impact the same body of water all such discharges must be considered in the calculations outlined above.

  The MOS is generally included implicitly according to the conservative assumptions discussed above. If it is not included implicitly, it must be stated explicitly.

Notes:

If the standard is suitable, the TMDL should be converted to a mass loading by simply multiplying the final mixed concentration by the total stream flow. Note that the total stream flow may include flow contributed by the discharge.

For mass loadings: all the WLAs and the LA are simply summed to determine the TMDL (include the MOS if it is not implicit in the calculations).

For materials that cannot be converted to mass loadings simply list the WLAs, the LA (include the MOS if it is not implicit). The TMDL is generally in the same units as the standard.

Documentation:

Documentation consists of the calculations that demonstrate that the resultant of the WLAs, LA and MOS will result in attainment of the standard. Note that in many cases (toxic materials) this documentation will, in fact, represent the meaningful part of the TMDL. This is a routine part of permit issuance and the tools that are used to derive permit limits are sufficient.

The TMDL and its components can be converted to a mass loading only if the standards are expressed as a simple concentration not to be exceeded at a specified flow. Otherwise, the TMDL and its components should be expressed in the same units that the standard is written in. For example:

> The D.O. standard is expressed as **minimum** concentrations and applies at all flows above or equal to the 7Q10. Since these are minimum standards, a maximum D.O. is not addressed. A TMDL (and all of its components) for D.O. should therefore be expressed as minimum concentrations.
>
> The TMDL for materials related to D.O. (such as BOD) is derived in terms of steady state concentrations that apply at the 7Q10 stream flow. Although not technically accurate, the TMDL for BOD may be expressed as a mass loading to satisfy federal regulations.
>
> The Chlorine standard is presently expressed as a concentration at specified flows. Although not technically accurate, the TMDL for CL2 may be expressed as a mass loading to satisfy federal regulations.
>
> The Temperature, fecal coliform, radiological, pH and similar standards are expressed in units that cannot be reasonably converted to a mass loading. The TMDL should be expressed in the same terms that the standard is written in.
>
> The standards for toxic materials are expressed as average concentrations of a specified duration that may occur at a specified frequency regardless of stream flow. The TMDL for these materials cannot be reasonably expressed in terms of a maximum or as a mass loading. The TMDL should be expressed in the same terms that the standard is written in.

Antidegradation:

When antidegradation applies to the segment being analyzed, no modification is needed to the TMDL routine procedures. The antidegradation baselines established in accordance with Guidance Memorandum #93-015 become the effective standard. The aggregate impact of the WLA, LA and MOS must not result in exceedences of the antidegradation baselines.

Recommendations:

1. The public notice for permit issuance to a water quality limited segment should contain references to the establishment of a TMDL concurrently with the permit's issuance (see Appendix I).

2. When a draft major permit needing a TMDL is issued, reissued, or modified, the submittal letter to EPA for their review should contain a notification (see Appendix II) that the draft permit fact sheet also contains draft TMDLs that will require separate review and comments. Note: both the permit and TMDL are in draft form at this stage.

3. Once public notice is complete, a copy of the public notice, and resolution of comments pertinent to the TMDL should be attached to the draft TMDL and submitted to EPA as the final TMDL for their approval.

4. When a permit is prepared for a single discharger to a water quality limited segment, the permit writer should include sufficient material in the fact sheet to develop and document the permitting decisions and a TMDL for the appropriate parameters (with the components documented and clearly identified in the fact sheet (see Appendix IV)).

5. When a permit is prepared for a facility to a water quality limited segment that receives multiple discharges, the TMDL may be developed during the processing of any one of the permits and reevaluated and/or confirmed during issuance of each permit to the segment.

6. When a minor permit needing a TMDL is issued, reissued, or modified, the permit fact sheet should contain sufficient documentation that will allow EPA to review and approve the included TMDLs. Note, that the TMDLs will have to contain the public notice and resolution of comments. **The region should submit these TMDLs directly to the EPA 303(d) coordinator.**

Note: the submittal of the final TMDL cannot be accomplished during EPA's routine review of permits because the public notice and resolution of comments received will not be available.

If you have any questions on the procedures presented or the contents of this guidance document, please feel free to contact Dale Phillips or Charlie Martin.

Appendix I

Suggested Public Notice Language

The following should be added to the public notice for any permit fact sheet that contains TMDLs.

> The Department of Environmental Quality intends to submit to EPA, the following dry weather Total Maximum Daily Loads (TMDL) for the receiving stream:
>
> (identify stream segment and river miles)
>
> (list parameters and TMDLs).
>
> These TMDLs are being noticed solely for informational purposes and to solicit public comment. They are not regulatory in nature and are not mandatory requirements. They are subject to reevaluation and modification with the issuance of any permit authorizing a discharge to this stream segment. Public notice and opportunity for public comment for all such reevaluations or modifications will be given.

Note to permit writers: It is recommended that TMDLs be developed only with permit issuance but may be done during modification, reissuance or in the absence of any permit actions if resources allow. In the event, that the TMDL is being developed in the absence of a permit action, it must still receive public participation. In that case the wording in the above can still be used.

Appendix III

Miscellaneous Concepts and Explanations

Mass loading:

When the amount of material is expressed as a maximum concentration (mass/volume) and applies at a specified stream flow (volume/time), it can be expressed as a mass loading rate (mass/time):

$$(m/v)(v/t) = m/t$$

where: m = mass
v = volume
t = time

Two things are necessary for a material to be specified as a unique mass loading: a concentration and its associated flow rate or volume. If either is missing then a mass loading cannot be calculated. In addition if either is variable then the mass loading is valid only for the specific values used in the calculation. It is generally not true that a specific concentration can be attained by holding the mass loading to a stream constant.

Problems with mass loadings and TMDLs:

There are several problems with the concept of mass loading and the term TMDL that makes its application somewhat misleading for many, or perhaps most, situations. The regulations are silent on these points but they are the primary reasons that TMDL development was not performed 25 years ago as envisioned by the Clean Water Act. The permit writer should be aware of these issues so that public questions/comments can be adequately and factually addressed.

1. All water quality processes are functions of concentration.

2. No Water quality process is a function simply of the total mass present in a system.

3. The term TMDL is misleading because it implies (and is generally considered to be) a constant maximum amount of a pollutant that may be present in a system. Unless there is a standard that establishes a maximum concentration this is simply not true and even in this case the cap is in terms of concentration and not loading.

4. If the stream contains a concentration, under all conditions, equal to the standard then it will always attain the standard regardless of the flow and the resultant mass loading. The only restriction on the mass loading in this case is the physical ability of the channel to carry the flow!

5. The majority of discharges to free flowing streams represent a source of additional flow to the stream. The amount of

pollutants that can be discharged is a function of this additional flow. If the flow changes (in either direction) then so does the amount of pollutant that can be discharged.

6. The amount of a material allowable in a stream is accurate for only one particular point in the stream and is not generally applicable to an entire segment. As the material decays, is diluted, or leaves the system in one of myriad ways then a capacity for additional material is created, e.g., the assimilative capacity for BOD changes continually as one moves downstream and, thus, so does the TMDL.

7. When a water quality standard specifies the maximum concentration of material that may be present in a stream, the TMDL is absolutely defined by that standard. Further, it is a simple fact that, when both are expressed in the same units, they must be numerically equal.

Calculation of TMDLs:

A TMDL is generally specified for the location where complete mixing is attained and other processes are ignored. For example, using the following equation:

$$Cm = \frac{CdQd+CsQs}{Qd+Qs}$$

Where: Cm = mixed concentration (equal to the standard and TMDL in many cases)
Cd = concentration in the effluent (=WLA)
Cs = background concentration in the stream (=LA)
Qd = flow rate of the discharge
Qs = flow rate of the stream

The margin of safety is incorporated implicitly into the assumptions applied during selection of the values for the parameters in the above equation, e.g., All parameters are at critical values simultaneously and persist at those values indefinitely.

Note that Cd can be, and often is, larger than Cm due to dilution. Only in the case of a dry ditch (Qs = 0) will Cd be equal to Cm. In no case is it necessary to make Cd be less than Cm

<u>For materials that can be specified as a mass loading:</u>

WLA = CdQd
LA = CsQs
MOS = implicit in assumptions by which the WLA is calculated or is explicitly stated.
TMDL = Cm(Qd+Qs)

For materials that cannot be specified as a mass loading:

WLA = Cd
LA = Cs
MOS = implicit in assumptions by which the WLA is calculated or is explicitly stated.
TMDL = Cm + documentation to demonstrate that the standard is met.

Notes: Cd, Cs and Cm are in the same units as the standard.
Cm is equal to the standard
Cd can be, and often is, much larger than Cm

For materials that are specified according to judgement or a narrative standard:

WLA = Best professional judgement
LA = Cs
MOS = Best professional judgement (must be explicitly stated)
TMDL = Cm(Qd+Qs) + MOS (if stated as a loading)
TMDL = Cm (if not stated as a loading)

Appendix IV

Example TMDL

Note: In this example only one permit is being issued and the fact sheet referred to is associated with that permit. Parts of it must address the other effluent; particularly the TMDL portions. This material and analysis must be reevaluated when the other permit is issued.

TOTAL MAXIMUM DAILY LOADS:

Note to permit writers: This should be a separate section in the fact sheet and should contain most or all WLA/limits documentation. We are recommending that priority be given to the 303(d) listed streams for parameters that are currently not attaining standards. If resources are available, TMDLs may be developed for all parameters that result in water quality limited effluent limits.

The current 303(d) list identifies the segment of Big Creek from river mile 10 to river mile 20 as not attaining the following standards.

Dissolved Oxygen
Fecal Coliform Bacteria
Copper (chronic)
General standard (color)

There are two point source discharges to the segment:

Metropolis - 5 MGD POTW @ river mile 19
Widgets, Inc. - 2 MGD industrial WTP @ river mile 20

Dry weather TMDLs will be calculated for the standards that are not being attained in this segment. The critical flows at mile 20 are:

7Q10 = 10 MGD.
1Q10 = 9 MGD
30Q5 = 14 MGD
Harmonic mean = 3 MGD

<u>TMDL for BOD:</u>

Although there is no stream standard for BOD, it must be limited due to its impact on the dissolved oxygen resources of the stream.

The regional stream model was used to determine the WLAs for the two point sources. The printouts are on pages xx to xx of this fact sheet. Note that TKN is used as a control for nitrogenous BOD. The results are:

Metropolis cBOD5 = 10 mg/l average @ 5 MGD = 417 lb/day
Metropolis TKN = 5 mg/l average @ 5 MGD = 208 lb/day
Metropolis D.O. = 6 mg/l minimum

Widgets cBOD5 = 12 mg/l average @ 2 MGD = 200 lb/day

Widgets TKN = 4 mg/l average @ 2 MGD = 67 lb/day
Widgets D.O. = 6 mg/l minimum

These wasteload allocations are for the dry weather flow condition when non point sources can be expected to be insignificant. Based on general monitoring data, the model assumes that the background concentration of cBOD5 under drought conditions is 2 mg/l. This translates to 166.8 lb/day.

Based on general monitoring data, the model assumes that the background concentration of degradable nitrogen compounds under drought conditions is zero. That value will be used to represent the load allocation under drought conditions.

Based on general monitoring data, the model assumes that the background D.O. is 90% of saturation or 7.6 mg/l during critical conditions.

During development of the WLA, it is assumed that both effluents are at the design flow, the stream is at 7Q10 drought flow, and both effluents are at the maximum allowable concentrations. It is assumed that these conditions occur simultaneously and persist indefinitely. This very conservative assumption provides an ample margin of safety that is incorporated implicitly into the calculations.

The dry weather TMDLs that will result in attainment of the dissolved oxygen standard are:

cBOD5 = 717 lb/day
TKN = 275 lb/day
D.O. = 6.0 mg/l

Note: The above loads are determined by calculating the loading (design flow X allowable concentration) for each discharger and the background and summing them. The weekly average permit limit is used for the domestic facility and the daily maximum is used for the industrial facility.

Note to permit writers: Insert or reference the model output here.

<u>TMDL for fecal coliform:</u>

The disinfection policy adopted by the Board requires that effluents from all point source discharges be in compliance with the water quality standard for fecal coliform bacteria at the end of the pipe. It results, that when such limits are placed into a permit, the effluent has no reasonable potential to either cause or contribute to a violation of the standards. Both facilities addressed here such limits. When the effluent itself it required to meet the standard and no credit is given for mixing or assimilation, an ample a margin of safety is implicitly included in such a policy.

Note: There will remain a fecal coliform problem in this segment that will have to await a wet weather TMDL to identify and correct. The LA and MOS will be developed by the Department of Conservation and Recreation at a later date. The TMDL documented here is a dry weather TMDL and addresses only the point source discharges.

The WLAs for fecal coliform are:

Metropolis = 200 mpn/100 ml.
Widgets = 200 mpn/100 ml.

The standard directly specifies the maximum amount of fecal coliform bacteria that is allowed in the stream. This allows the TMDL for fecal coliform bacteria to be identified in spite of the fact that the LA and MOS are presently still unidentified:

TMDL for fecal coliform bacteria = 200 mpn/100ml.

TMDL for Color:

The color in this segment of stream originates from the Widgets, Inc. effluent. The color above the Widgets effluent is 50 pcu. According to the literature and the judgement of the permit writer, 100 pcu in this stream should be barely perceptible and should be acceptable. The effluent is being limited such that the resultant color in the stream will be 100 pcu during low flow dry weather conditions. The Metropolis effluent is not colored and does not contribute to the problem. No WLA for Metropolis is required.

The dry weather LA is established according to the observed background color:

LA = 50 pcu.

During development of the WLA, it is assumed the effluent is at its design flow, the stream is at 7Q10 drought flow, and the effluent is at its maximum allowable color. It is assumed that these conditions occur simultaneously and persist indefinitely. This very conservative assumption provides an ample margin of safety that is incorporated implicitly into the calculations.

A complete mix equation was used to estimate the color allowable in the effluent (WLA):

$$WLA = \frac{100(10+2)-(10)(50)}{2} = 350 \text{ pcu}$$

This WLA, once it is diluted by the stream, will result in an in stream color of 100 pcu. The TMDL for color is therefore 100 pcu.

TMDL for Copper:

D solved copper was found to be present in both the Metropolis and W gets effluents.

T MIX.EXE program was used to analyze the mixing zones associated w h these discharges. It resulted that the mixing zone for Widgets i about 2500 feet long and complete mixing is achieved before the f w gets to the Metropolis discharge point. The mixing zone for . ropolis is about 2000 feet long. It results that WLAs may be e blished by application of complete mix assumptions and further may b done separately for each effluent because the mixing zones do no c rlap. The modeling results demonstrate that the mixing zones do . overlap and that a complete mix assumption is appropriate.

N e to permit writers: insert or reference MIX.EXE output here.

N e to permit writers: if the mixing zones overlap then the a regate mixing zone must meet the exposure requirements established j amendment #1 to guidance document # 93-015. This would be done by c culating the exposure time (based on stream velocity) between the e luents and then the exposure time below the last effluent. The t al time must meet the criteria.

T WLA.EXE program was used to analyze the effluent data distribution a to calculate the statistics associated with it. It results that . its are required for both effluents.

N e to permit writers: insert or reference WLA.EXE output here.

B h discharges must be evaluated relative to their aggregate impact a the resource allocated between them.

T total allocation can be determined by application of a simple c plete mix equation:

$$Cm = \frac{(QsCs) + (QwCw) + (QmCm)}{(Qs+Qw+Qm)}$$

Where Cm = criteria for copper
Q refers to flow
C refers to concentration
m refers to Metropolis
w refers to Widgets.
s refers to the above Widgets stream.

T re are no data available for the stream, however, there is no i tifiable source of copper upstream of the Widgets effluent and b logical monitoring indicated no problem above the Widgets effluent. T background concentration of copper will be assumed to be zero.

T resource will be allocated equally between the dischargers so C = Cm = Cd and Qd = Qw+Qm so:

$$Cm = \frac{(QsCs)+(QdCd)}{(Qs+Qd)}$$

where Cm = Std = 4
Cs = LA = 0
Qs = 10
Qd = Qw+Qm = 7

Solution of this equation for Cd yields the WLA (9.7) for each discharger.

Note to permit writers: There are many allocation alternatives possible and the exact method to be used may require different documentation. Possible alternatives to consider may include:

- agreed to by dischargers
- equal concentration limits
- equal mass limits
- flow weighted limited
- equal degree of removal

WLAs for Copper:

Widgets Inc.:

9.7 ug/l daily maximum (This is the 97th percentile of the distribution of daily observations that this effluent must comply with.)

12.8 ug/l monthly average (This is the 97th percentile of a distribution of averages based on four samples per month.)

The daily maximum WLA will be used to establish the TMDL.

Metropolis:

9.7 ug/l Weekly average (This is the 97th percentile of a distribution of averages based on two samples per week.)

11.4 ug/l monthly average (This is the 97th percentile of a distribution of averages based on eight samples per month.)

The weekly Average WLA will be used to establish the TMDL.

The standard for dissolved copper is a 4-day average concentration of 4 ug/l that may be exceeded no more than once in three years on the average. This standard directly specifies the amount of copper

allowed in the stream and therefore the TMDL for copper = a 4-day average concentration of 4 ug/l that will be exceeded no more that once in three years.

During development of the WLAs for the above toxic materials, it is assumed the effluents are at their design flow, the stream is at the critical low flow, the pH is at its 90th percentile, the temperature is at its 90th percentile and the hardness is at its mean value. It is assumed that these conditions occur simultaneously and persist indefinitely. This conservative assumption provides an ample margin of safety.

Note to permit writers: The above paragraph needs to be included only once for all toxic parameters that the methods used apply to.

Note: Federal law requires that permit limits be written in terms of a daily maximum and a monthly average for industrial permits and a weekly average and a monthly average for POTWs. EPA has required us to retain and use this terminology regardless of technical considerations. The existing guidance recommends monthly average and daily maximum limits. However, where a discharger objects, the limits for POTWs must be written as monthly and weekly averages. This requirement is not really applicable to materials whose standards are expressed statistically and should not have been applied to these limits, however, EPA region III will not accept any alternatives. This requirement prevents the permit limits for copper from being written in accordance with the technical protocols that the limits are based on. Note that the limits are based on a statistical analysis of the effluent and are expected to be exceeded once in each three year period but due to regulation this cannot be recognized in the permit. As a result, the WLA, TMDL and permit limit specify different actual requirements and are in different units.

Summary of TMDLs:

The TMDLs listed here for cBOD, TKN, D.O., Color and Copper are expected to provide attainment of the water quality standards. The TMDLs listed for fecal coliform bacteria will provide attainment of the water quality standard during dry weather, low flow conditions.

Parameter	TMDL	WLA	LA	MOS
cBOD5[1]	784	M 417 W 200	166.8	implicit
TKN[1]	275	M 208 W 67	0.0	implicit
D.O.[2]	6.0	6.0	7.6	implicit
Color[3]	100	W 3508	50	implicit
fecal[4]	200/100	200/100	N/A	implicit

coliform

Copper	4[5]	M 9.7[6] W 9.7[7]	0.0	implicit

M preceding WLA refers to Metropolis
W preceding WLA refers to Widgets
if no prefix, WLA refers to both effluents

1 - TMDL, WLA and LA expressed as lb/day
2 - TMDL, WLA and LA expressed as minimum mg/l
3 - TMDL, WLA and LA expressed as maximum platinum cobalt color units (pcu)
4 - TMDL, WLA and LA expressed as MPN/100 ml
5 - TMDL is expressed as 4 day average ug/l not to be exceeded more than once in three years.
6 - WLA expressed as weekly average mg/l
7 - WLA expressed as daily maximum mg/l

The fecal coliform TMDL is accurate. However, the LA is not identified by this phase I TMDL.

Public Participation:

Note to permit writers: This section cannot be completed until after public notice and a successful response to the comments received.

Attach a copy of the public notice.

Attach a copy of public notice verification.

Attach copy of actual comments received.

Attach copy of response to comments.

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
Office of Permit Support

629 East Main Street Richmond, Virginia 23219

M E M O R A N D U M

Subject: Response to selected concerns that were raised during preparation of the TMDL guidance

To: John Daniel

From: M. Dale Phillips

Date: October 16, 1997

Copies:

There were some questions/comments that occurred during preparation of this guidance frequently enough so additional discussion is indicated. This section is included to provide that discussion, background and insight.

Segments that TMDLs are required for:

The law and regulations require TMDLs for all waters for which the effluent limitations required by sections 301(b)(1)(A) and 301(b)(1)(B) of the clean water act are not stringent enough to implement any water quality standard. The sections of the law referred to establish the technology based requirements for industry and secondary treatment for POTWs.

It results that all water quality based effluent limits theoretically require a TMDL.

This guidance recognizes that fact but also recognizes that the highest priority is for those facilities that also discharge to segments that are currently on the 303(d) list and that task may require all available resources for the immediate future.

The development of TMDLs for segments not on the 303(d) list is left to the discretion and resource availability of the regions.

Note: TMDLs must eventually be developed for all water quality limited segments and submitted to EPA regardless of the classification of the discharger, e.g., minor facilities require TMDLs if they discharge to a water quality limited segment. Further, all TMDLs require EPA review and approval.

Segments that TMDLs will not be calculated for:

There are currently many segments on the 303(d) list are misclassified and have inappropriate standards assigned to them. When the standards are in error there is no possibility of calculating a valid TMDL because, by definition, there are no point or nonpoint source controls that will result in the waters meeting the erroneous standards.

This situation occurs most frequently in swamp waters. Guidance for establishing permit limits for these waters was implemented years ago and there should be no problem with the regional offices identifying these waters to OERS so the appropriate classification and standards can be applied to them.

Any time an error in the classification of a stream leads to improper standards being applied, no TMDL for that stream should be attempted until the error is corrected.

Dry Ditches:

There should be no problem with establishing a TMDL for a dry ditch that receives an effluent. The dry weather LA is by definition equal to zero (there is no background flow). The WLA is the aggregate effect of all dischargers and the margin of safety is as discussed in this guidance.

Segment boundaries:

For segments contained in the 303(d) listing, the boundaries are identified and the permit writer will not have to address this aspect of TMDL development.

Note: For those unfamiliar with this listing, the 303(d) listing is available from the regional planners.

For segments that might require TMDLs but are not on the 303(d) listing the regional office will have to develop segment boundaries. It will be a regional decision as to who is responsible for this. However, the planning sections developed the 303(d) boundaries and are familiar with the requirements and defaults.

Parameters:

TMDLs need to be developed only for parameters that have water quality based limits or parameters that result in violation of a water quality standard. For example:

> If a segment is on the list only for ammonia toxicity violations then only an ammonia TMDL is required.
>
> If a segment has water quality limits for BOD and technology limits for temperature, then only a BOD TMDL is required.

Does the permit need to be modified:

Although the TMDLs are developed in conjunction with permits, there are no modifications to the permit required by TMDL development. The permit will still look exactly like before in all ways. The only thing that changes is certain portions of the fact sheet. However, if the region desires the TMDL can be a completely separate document. This would however require duplication of much of the material in the fact sheet.

The region is, however, cautioned to make sure that the TMDLs and the permit limits are consistent. That is the main benefit of developing them concurrently.

Nonpoint sources:

DEQ will develop TMDLs only for point sources. DCR will develop TMDLs only for nonpoint sources.

If the segment is on the 303(d) list solely due to point sources then DEQ will develop the TMDL. If the segment is on the 303(d) list solely due to nonpoint sources of pollutants then DEQ does nothing and DCR will develop the TMDL.

If the segment is on the list due to both point and nonpoint sources the then:

DEQ will develop a dry weather TMDL during permit issuance.

DCR will develop the nonpoint TMDL.

The two agencies will work together regarding the final TMDL.

We are still working on developing the relationship between DEQ and DCR and this guidance will be updated when that coordination is finalized.

Who approves what and other miscellany?

All TMDLs must be submitted to EPA for their review and approval (including those associated with minor discharges). No other approvals are required.

The responsibility for submittal to EPA is recommended to be with the regions. The central office will however maintain and extend the current assistance and liaison functions for permit issuance to include support for TMDLs; particularly, where they cross regional or state boundaries.

Filing, tracking, development responsibilities, etc. is solely at the regions' discretion.

The chemical specific toxic standards place no restriction whatsoever on the maximum concentration of materials allowable in the stream. Many have pointed out, if this is true, then holding and discharging huge amounts of materials once every three years would not violate the standards. That understanding is, in fact, correct.

Such a practice would violate other standards (general standard, WET, etc.) and would be prohibited but such events would not necessarily violate the chemical specific standards. Recall that EPA's stated rationale for these standards is to **allow toxic events to occur** but to limit the duration and recurrence of such events such that the system will have a chance to recover between them and no **permanent harm** will result.

According to this rationale, it is to be fully expected that minor toxic events will occur every three years and some temporary harm to the ecosystem is to be expected. An inescapable consequence associated with the acceptance of such a rationale is that extremely serious events will occur but the occurrence will not be frequent enough to permanently harm the system.

Recall that the standards and their implementation are statistically based and that in both a normal and log normal distribution there is no limit on the maximum value that a variable may take.

It has been noted that this rationale is not consistent with the concept of "no toxics in toxic amounts" associated with whole effluent toxicity. That inconsistency currently exists and is being addressed.

The procedures and concepts discussed in this guidance do not require modification for tidal Waters. It is recognized that the models and technical considerations will be considerably more difficult for these waters and that multiple discharge situations will be considerably more difficult to analyze and quantify. It is also recognized that professional judgement may play a much more important role in tidal waters. However, if one can identify appropriate permit limits then one can also develop a dry weather TMDL.

The technical approaches that DEQ will use to determine TMDLs are in routine use and are described in other documents that pertain to establishing permit limits. These require reference only, e.g., modeling guidance, mixing guidance, toxics limits guidance, etc. This guidance does not recommend changes to those routine procedures.

It is assumed that the permit writer is familiar with implementation of those procedures associated with permit issuance.

The main goal of this guidance is to make recommendations on how to package the information that we normally produce as acceptable TMDLS. A secondary goal is to provide sufficient background and theory to better enable the permit writer to respond to comments and questions that arise during public participation and EPA review.